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ADDENDUM TO SPECIFICATIONS FOR INCINERATOR TESTING AT FEDERAL FACILITIES

National Center for Air Pollution Control
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ADDENDUM
TO
SPECIFICATIONS FOR INCINERATOR TESTING
AT
FEDERAL FACILITIES

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Public Health Service
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National Center for Air Pollution Control

December 6, 1967

ADDENDUM TO SPECIFICATIONS FOR INCINERATOR TESTING AT FEDERAL FACILITIES

The following material is supplied as a supplement to the publication, "Specifications for Incinerator Testing at Federal Facilities."

ALTERNATIVE METHOD FOR COMPLIANCE TESTING

An alternative method for determining particulate emissions, which has the same stringency as the present method based on carbon dioxide measurements, but permits simpler, less expensive, sampling procedures, may be followed if tester so desires. Since gas washers appear to absorb carbon dioxide, the corrected grain loadings of stack gases from these devices may be excessively high. The alternative method, not being based on carbon dioxide measurements, avoids this possibility.

To use the alternative method, tester must determine the pounds per hour of particulate emitted. To be in compliance, incinerator emissions in pounds per hour must not exceed that indicated in Figures 1 and 2. In general, allowable emissions measured by the alternative method correspond to the amounts allowed in Section 2.2.

In using the alternative method, it is necessary only to sample for particulates and determine emissions in pounds per hour. It is not necessary to measure carbon dioxide during test runs, or determine carbon dioxide emitted from burning auxiliary fuel.

Whichever method for determining compliance is used, the general testing procedures detailed in "Specifications for Incinerator Testing at Federal Facilities," and this Addendum will apply, with the following modification.

In testing with the pounds per hour method, Section 6.2, describing techniques for measuring carbon dioxide from burning auxiliary fuel, and

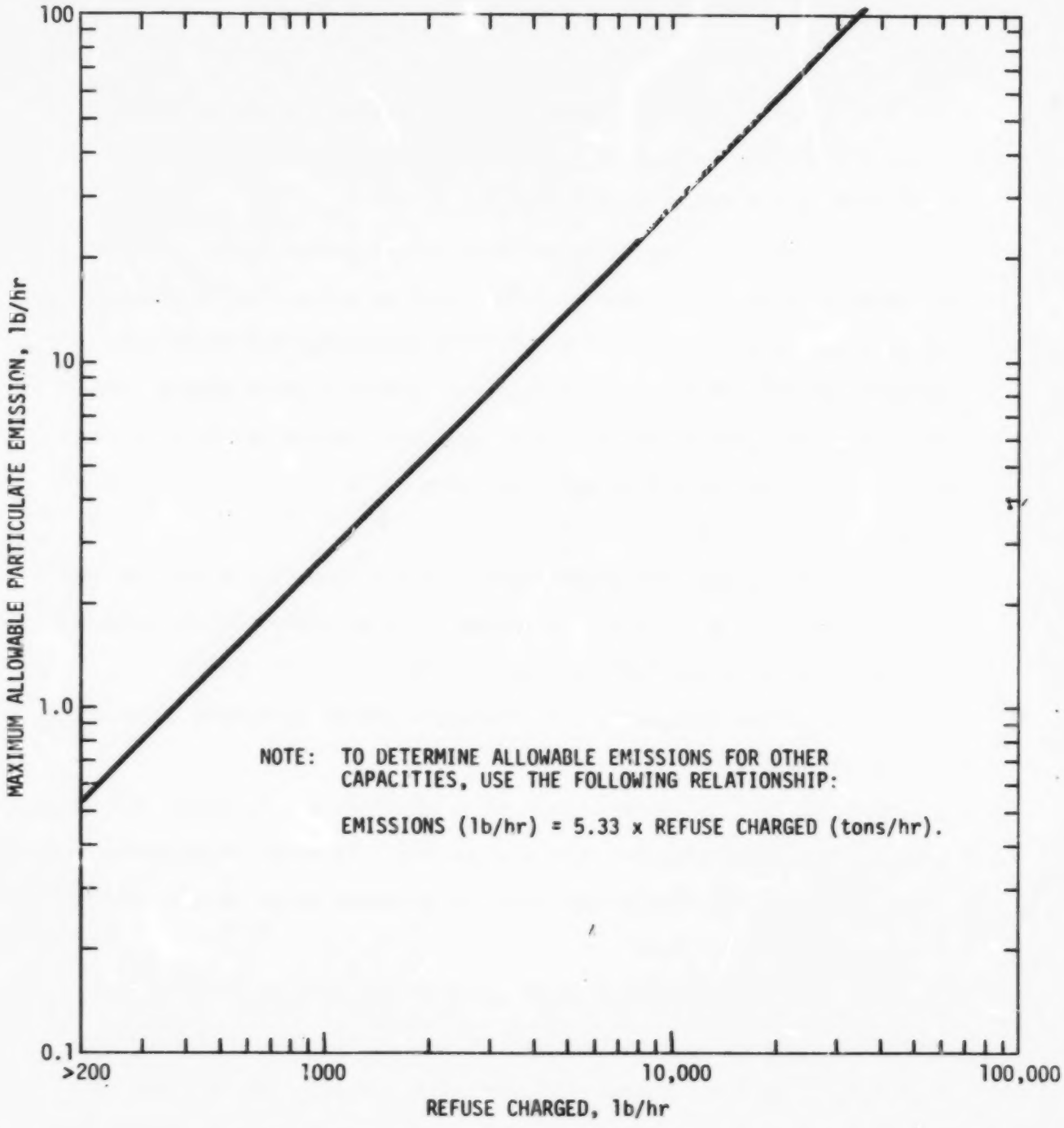


Figure 1. Maximum allowable emission of particulate matter from refuse burning units with capacities greater than 200 pounds per hour.

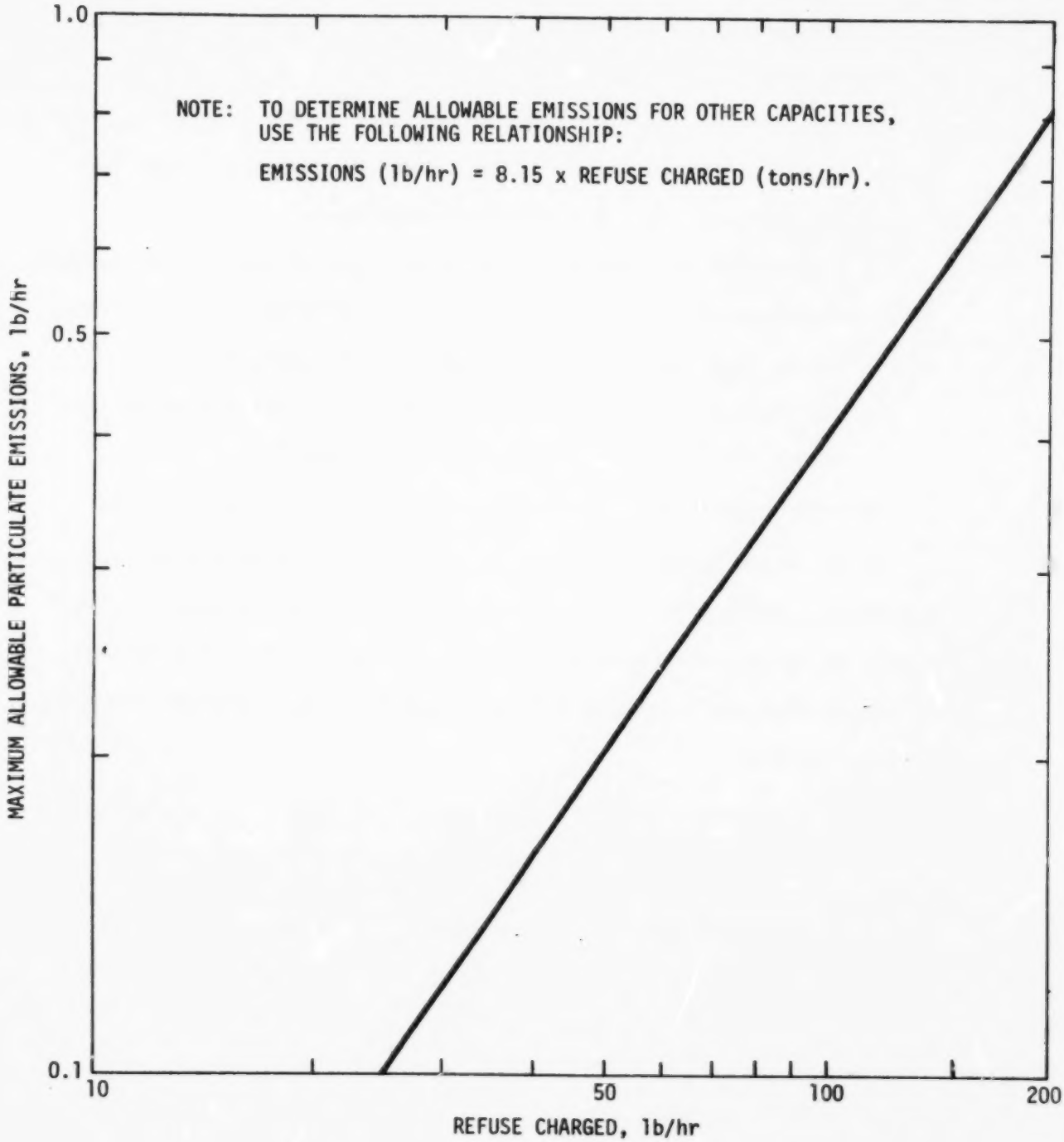


Figure 2. Maximum allowable emission of particulate matter from refuse burning units with capacities of 200 pounds per hour or less.

Section 8, describing the carbon dioxide sampling apparatus, need not be followed. In addition, Section 12.1, reporting results, should be modified so that particulates are reported as pounds of particulate emitted per hour.

PARTICULATE SAMPLING PROCEDURES

When possible, single-point sampling conducted at the point of average stack velocity, should be used for general-refuse incinerators. Such sampling may be conducted under the following conditions:

1. The sampling location is in a vertical duct, at least eight diameters downstream from any bend, expansion, construction, or visible flame and at least two diameters upstream from any bend, etc.
2. The ratio of the maximum to the minimum gas velocity as found from the preliminary velocity traverse is less than 2.

Where these conditions are met, the time of each run shall be 1 hour.

If any of the foregoing conditions are not met, then it will be necessary to perform a sample traverse. In such a traverse the sample probe is placed at each of the velocity traverse points for a length of time given in Table 1. The sample probe shall be moved from one traverse point to another immediately prior to charging.

Table 1. DURATION OF TEST RUNS

Total number of traverse points	Sampling time per point, minutes	Total run time, minutes
1	60	60
4	15	60
6	10	60
8	10	80
9	5	45
>9	5	Number of points x 5

In order to facilitate operation of the particulate train at isokinetic conditions during sampling, the nomographs of Figures 3 and 4 may be used. These nomographs, designed for use with the particulate train described in Section 7.4, make it possible to rapidly adjust the sample rate to isokinetic conditions without other computations.

The nomograph of Figure 3, The Operating Nomograph, is used to adjust the sampling rate to maintain isokinetic conditions. The nomograph of Figure 4, The Correction Factor Nomograph, is used to adjust the Operating Nomograph to field conditions. Procedures for using these nomographs are as follows:

1. Determine ΔH_a (the standard orifice pressure drop, in. water), for train by measuring orifice pressure drop at a flow rate of 0.75 cfm, a meter temperature of 70°F, and a meter pressure of 29.92 in. Hg* (once determined, ΔH_a is constant for a given train and orifice).

2. Estimate probable T_m (meter temperature), often 25°F above ambient temperature; % H_2O (moisture in stack gas), and P_s/P_m (ratio of stack pressure to meter pressure).

3. Determine Correction Factor "C" using nomograph of Figure 2 as directed thereon and with values estimated above.

---

* An orifice pressure drop (ΔH_b) can be measured at any pressure and temperature, and corrected to standard conditions by the formula below:

$$\Delta H_a = 0.0564 \times \Delta H_b \times \frac{T_b}{P_b} .$$

ΔH_b = Orifice pressure drop @ T_b, P_b and a flow rate of 0.75 cfm.

T_b = Meter temperature, °Rankin.

P_b = Barometric pressure + orifice pressure drop, in. Hg.

4. Set Correction Factor "C" on sliding scale of Operating Nomograph (Figure 1) opposite Reference Point 1.

5. Make a rough pitot traverse, and determine minimum, average, and maximum values for Δp (pitot reading, in. water).

6. Measure T_s (the stack temperature), ^{o}F.

7. Draw line from T_s to the values of Δp found in step 5 above. Select a convenient D (nozzle diameter) from the range of values indicated on the probe tip diameter scale.

8. Draw line from T_s through D chosen in step 7 to obtain a value for Δp.

9. Draw a line from the value for Δp obtained in step 8 above to Reference Point 2. on the ΔH (orifice reading) scale to obtain a pivot point on the K-factor scale. This point should be marked for future reference.

10. During sampling, determine the ΔH necessary for isokinetic sampling by aligning pitot readings (Δp) with the K-factor pivot point determined in step 9 above. Adjust sample flow rate to produce desired ΔH or orifice manometer. The train will then be sampling isokinetically.

11. If T_s changes, repeat steps 6 through 10 above.

DATA AND CALCULATION REPORTING FORMS

The data and calculation forms provided herein are for recording data and for calculating and reporting test results in a standard manner. An instruction sheet accompanying the forms explains how they should be used. The forms are to be submitted with the other information required under Section 12, Reporting Results, of the original publication.

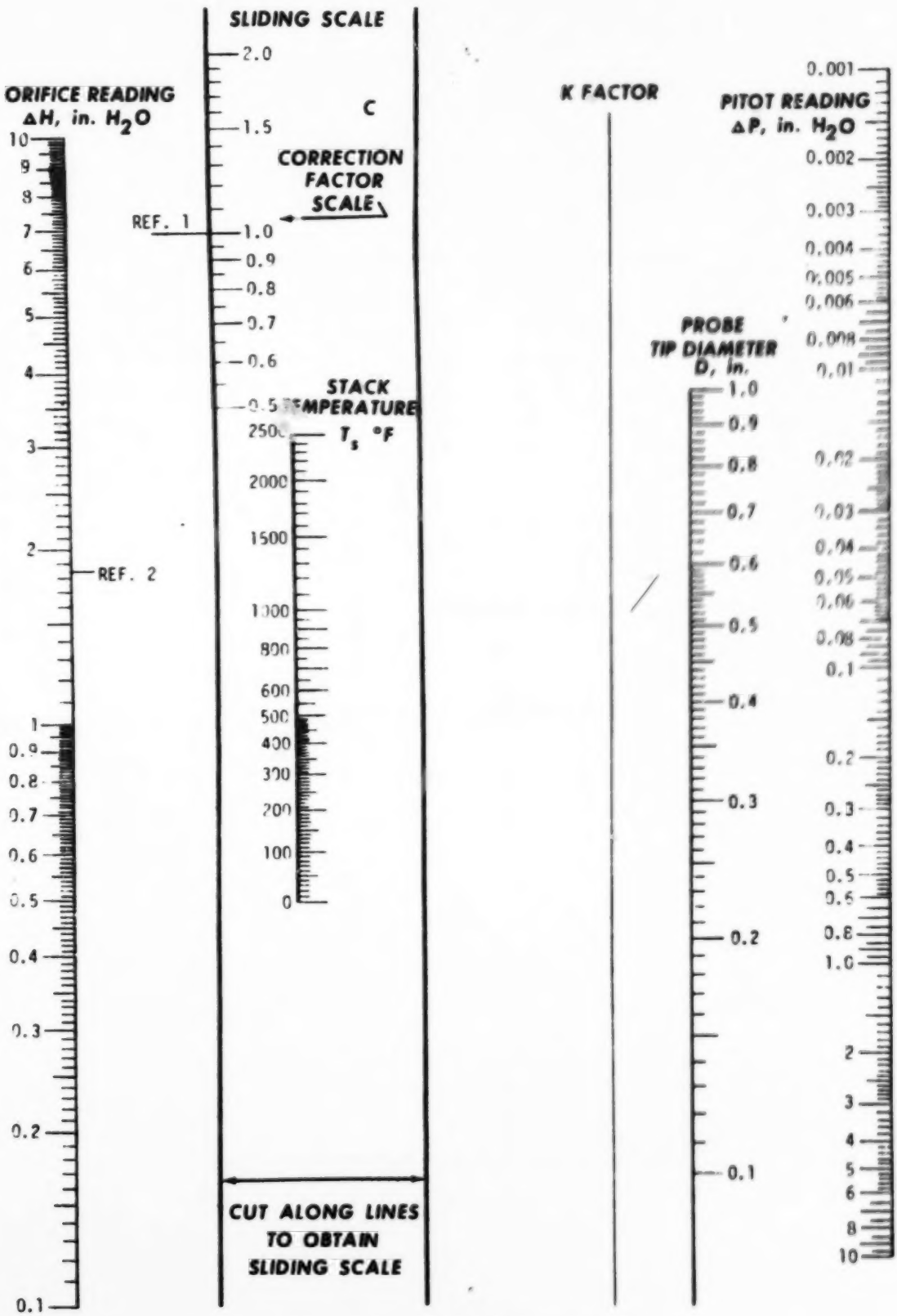
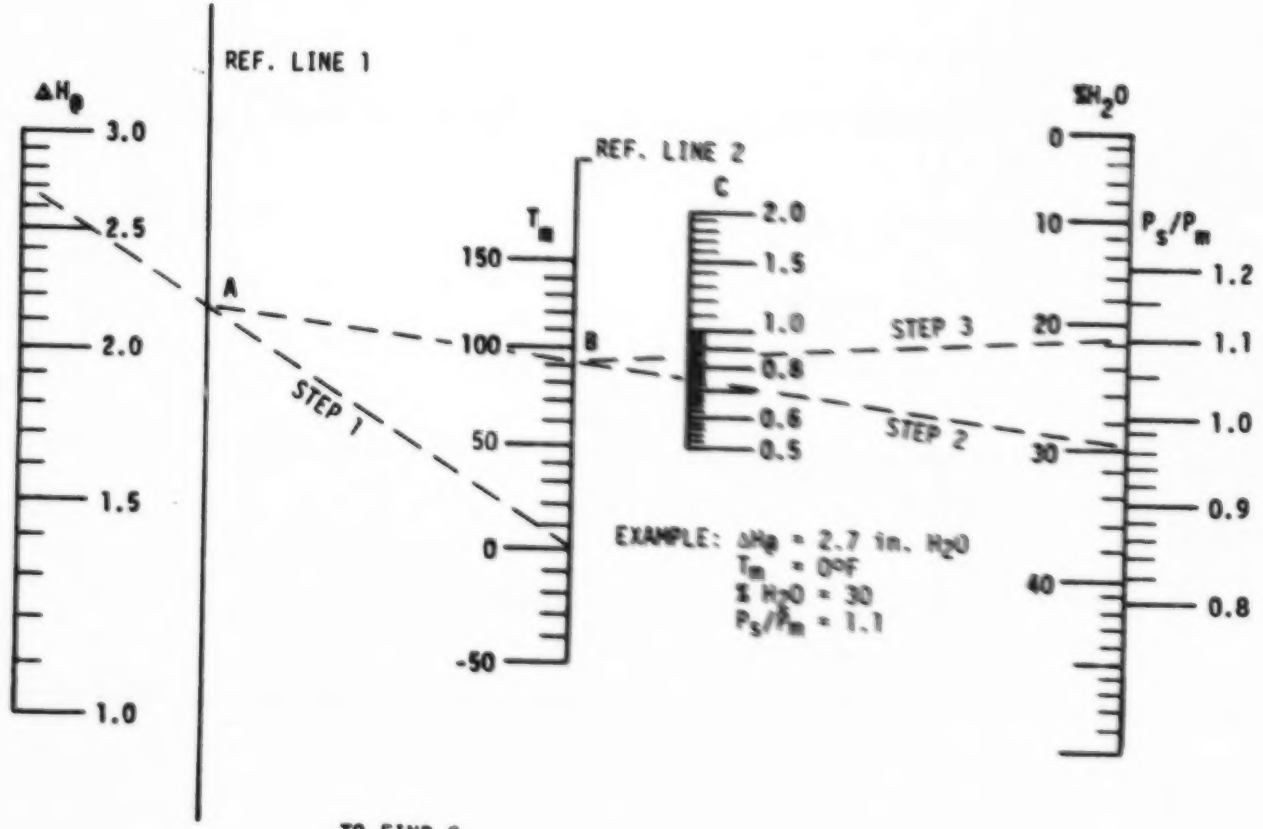


Figure 3 Operating nomograph.



TO FIND C:

STEP 1: DRAW LINE FROM ΔH_g TO T_m TO OBTAIN POINT A ON REF. LINE 1.

STEP 2: DRAW LINE FROM A TO $\% H_2O$ AND READ B ON REF. LINE 2.

STEP 3: DRAW LINE FROM POINT B TO P_s/P_m, AND OBTAIN ANSWER OF 0.85 FOR C.

Figure 4 Correction factor nomograph for Figure 3

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Instructions for Filling Out Source Testing Calculation Forms for Incinerators

To complete these forms, the following instructions should be adhered to:

1. When using the pounds per hour method to determine compliance, only Parts 8, 9 and 10 need be completed. If the grains per standard cubic foot corrected to 12 % CO_2 method is used to determine compliance, instructions 2 through 6 should be followed.

2. Fill out completely Parts 9 and 10.

3. Fill out completely Tables in Part 3, page 1; Part 4, page 1; Part 5, page 1; Part 6, page 1; and Part 7, page 1.

4. Fill out Summary of Test Data Sheet obtaining information from appropriate pages.

5. Use formulas in order as numbered in left hand margin starting in Part 3, page 1.

6. Transfer all appropriate data to Summary of Results Sheet, Part 1.

Note: These forms have been especially designed for use with the sampling trains described in "Specifications for Incinerator Testing at Federal Facilities."

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SUMMARY OF RESULTS

Incinerator Test

Run No. _____

1. Name of firm _____
2. Location of plant _____
3. Type of incinerator _____
4. Control equipment _____
5. Sampling point location _____
6. Material incinerated _____
7. Weight of material incinerated _____
8. Pollutants sampled _____

_____

9. Time of particulate test:

   Date _____, Begin _____, End _____

Operating Variables

10. Scrubber pressure drop, in. H_2O _____
11. Scrubber H_2O rate, gpm _____
12. Primary chamber draft, in. H_2O Overfire _____ Underfire _____
13. Secondary chamber temperature, ^oF _____
14. Stack temperature (T_{hd}), ^oF _____

Emission Data

15. Stack flow rate (V_{db}), scfm _____

16. Water vapor in stack gas (V_{cg}), % by volume _____

17. Excess air at sampling point (V_{bl}), % _____

	grains/cf at stack conditions	grains/scf	grains/scf at 12 % CO_2 *	lb/hr
18. Particulate - probe, cyclone	C_{as}=	C_{am}=	C_{ap}=	C_{av}=
19. Particulate - probe, cyclone, filter	C_{at}=	C_{an}=	C_{aq}=	C_{aw}=
20. Total particulate (includes impinger catch)	C_{au}=	C_{ao}=	C_{ar}=	C_{ax}=

21. Percent isokinetic for particulate train I_{ax}= _____

22. CO_2 in stack gas from burners**, % volume (dry) V_{bn}= _____

23. CO_2 in stack gas from waste, % volume (dry) V_{ba}= _____

24. O_2 in stack gas from waste and burners, % volume (dry) V_{bh}= _____

25. CO in stack gas from waste and burners, % volume (dry) V_{bq}= _____

26. N_2 in stack gas from waste and burners, % volume (dry) V_{bi}= _____

27. Sticky paper, particles/in.^{2} 60 microns and above _____

28. Sticky paper, particles/min. 60 microns and above _____

Legend: NM - not measured
scf = Standard cubic foot, i.e., dry gas at 70°F and 29.92 in. Hg.
Stack conditions: Stack temperature and stack pressure including moisture.

---

* Correction to 12 % CO_2 made using % CO_2 from waste only.

** % CO_2 from burner corrected to test conditions.

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SUMMARY OF TEST DATA

Date _____ Run No. _____

Particulate Sampling Train

1.	Sampling nozzle diameter, in.	D_{av} = _____
2.	Sampling time, min.	T_{aw} = _____
3.	Sample gas volume - meter condition, cf	V_{ac} = _____
4.	Average meter temperature, ^{o}F	T_{ai} = _____
5.	Average orifice pressure drop, in. H_2O	P_{af} = _____
6.	Particulate collected - probe and cyclone, mg	W_{aj} = _____
7.	Particulate collected - probe, cyclone and filter, mg	W_{ak} = _____
8.	Particulate collected - total, mg	W_{al} = _____

Velocity Traverse - Burner Only

9.	Stack area, $in.^2$	S_{dd} = _____
10.	Average stack pressure, in. Hg (absolute)	P_{hc} = _____
11.	Average stack temperature, ^{o}F	T_{hd} = _____
12.	Average $\sqrt{\text{velocity head x stack temperature}}$	S_{he} = _____
13.	Moisture in stack gas from burners, % by volume	V_{hi} = _____

Velocity Traverse During Test - Burner and Waste

14.	Stack area, $in.^2$	S_{dd} = _____
15.	Average stack pressure, in. Hg (absolute)	P_{di} = _____
16.	Average stack temperature, ^{o}F	T_{df} = _____
17.	Average $\sqrt{\text{velocity head x stack temperature}}$	S_{de} = _____

Stack Moisture Content

18.	Total water collected by train, ml	V_{ce} = _____

NCAP-17 (12/67)

Orsat Analysis - Burner Only

19. CO_2, % volume (dry) V_{bb} = _____

20. CO, % volume (dry) V_{bc} = _____

21. O_2, % volume (dry) V_{bd} = _____

22. N_2, % volume (dry) V_{be} = _____

Orsat Analysis - Burners and Waste

23. CO_2, % volume (dry) V_{bf} = _____

24. CO, % volume (dry) V_{bg} = _____

25. O_2, % volume (dry) V_{bh} = _____

26. N_2, % volume (dry) V_{bi} = _____

Incinerator Operating Data

27. Fraction of test time all burners are operating G_{bm} = _____

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PARTICULATE SAMPLING TRAIN DATA AND CALCULATIONS

Nozzle diameter (D_{av}), in. = _____

Barometric pressure (P_{aa}), in. Hg = _____

Sampling point location _____ Run No. _____

Clock time	Point No.	Gas Meter: Reading (V_{ac}) cf	Gas Meter: Temp. in °F	Gas Meter: Temp. out °F	Orifice Δ P in. H_2O

Net time min	Net	Average	Average	Average
(T_{aw})=	(V_{ac})=	(T_{ad})=	T_{ae})=	(P_{af})=

(1) A. Average meter temperature = $\frac{T_{ad} + T_{ae}}{2} = T_{ai}$ = _____

(2) B. Dry gas sample volume @ standard conditions, cf

$$= 17.7 \times V_{ac} \times \frac{P_{aa} + \frac{P_{af}}{13.6}}{(T_{ai} + 460)} = V_{ab} =$$ _____

Laboratory Data

Particulate - probe and cyclone (W_{aj}), mg = _____

Particulate - probe, cyclone, and filter (W_{ak}), mg = _____

Particulate - total (includes impinger washings) (W_{al}), mg = _____

Particulate Concentration Calculations

In grains/scf

(3) A. Particulate - probe and cyclone, grains/scf

$$C_{am} = 0.0154 \times \frac{W_{aj}}{V_{ab}} =$$ _____

(4) B. Particulate - probe, cyclone, and filter, grains/scf

$$C_{am} = \frac{0.0154 \times W_{ak}}{V_{ab}} =$$ _____

(5) C. Particulate - total, grains/scf
(Go to Part 6, page 1)

$$C_{ao} = \frac{0.0154 \times W_{al}}{V_{ab}} =$$ _____

In grains/scf @ 12 % CO_2

(17) D. Particulate - probe and cyclone, grains/scf @ 12 % CO_2

$$C_{ap} = C_{am} \times \frac{12}{V_{ba}} =$$ _____

(18) E. Particulate - probe, cyclone, and filter, grains/scf @ 12 % CO_2

$$C_{aq} = C_{an} \times \frac{12}{V_{ba}} =$$ _____

(19) F. Particulate - total, grains/scf @ 12 % CO_2

$$C_{ar} = C_{ao} \times \frac{12}{V_{ba}} =$$ _____

In grains/cf @ stack conditions

(20) G. Particulate - probe and cyclone, grains/cf @ stack conditions

$$C_{as} = \frac{17.7 \times C_{am} \times P_{di} \times Mch}{(T_{df} + 460)} = _____$$

(21) H. Particulate - probe, cyclone, and filter, grains/cf @ stack conditions

$$C_{at} = \frac{17.7 \times C_{an} \times P_{di} \times Mch}{(T_{df} + 460)} = _____$$

(22) I. Particulate - total, grains/cf @ stack conditions

$$C_{au} = \frac{17.7 \times C_{ao} \times P_{di} \times Mch}{(T_{df} + 460)} = _____$$

In lb/hr

(23) J. Particulate - probe and cyclone, lb/hr

$$C_{av} = 0.00857 \times C_{am} \times V_{db} = _____$$

(24) K. Particulate - probe, cyclone, and filter, lb/hr

$$C_{aw} = 0.00857 \times C_{an} \times V_{db} = _____$$

(25) L. Particulate - total, lb/hr

$$C_{ax} = 0.00857 \times C_{ao} \times V_{db} = _____$$

(26) M. % isokinetic $= \frac{1032 \times (T_{df} + 460) \times V_{ab}}{V_{dh} \times T_{av} \times P_{di} \times M_{ch} \times (D_{av})^2} = I_{ax} = _____$

(Go to Part 7, p. 1)

V_{ba} from Orsat data and calculation sheet (part 7).

V_{db}, T_{df}, V_{dh}, P_{di}, from velocity data and calculation sheet for test (Part 5).

M_{ch} from moisture content data and calculation sheet (Part 6).

D_{av} from particulate sampling train data and calculation sheet (Part 3).

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VELOCITY TRAVERSE DATA AND CALCULATION SHEET

(Burners Only)

Date _____ Time _____ Run No. _____

Sampling point location _____

Stack area (S_{dd}), $in.^2$ _____

Wet bulb temperature (T_{hj}), ^oF _____

Dry bulb temperature (T_{hk}), ^oF _____

Barometric pressure (P_{hl}), in. Hg absolute = _____

Note: Calculations for S-type pitot tube, C = 0.85

Drawing of stack cross section

Point No.	Distance from ref. point, in.	Stack press. (P_{hm}) in. Hg. (gage)	Stack Temperature (T_{hd}), ^oF	Stack Temperature (T_{hd} + 460), ^oR	Velocity head (V_a), in. H_2O	$V_a \times (T_{hd} + 460)$	$\sqrt{V_a \times (T_{hd} + 460)}$
		Avg = ____	Avg = ____				Avg (S_{he}) = ____

in. Hg (abs) = _____

(P_{hc}) = P_{hm} + P_{hl} = _____

(9) A. Moisture in stack gas, from wet and dry bulb temperatures using psychrometric charts (V_{hi}), % = _____

(10) B. Mole fraction of dry gas

$$= \frac{100-V_{hi}}{100} = M_{hg} = _____$$

(11) C. Stack velocity @ P_{hc} and T_{hd} (stack conditions, includes moisture), fpm

$$= 4350 \times S_{he} \left[\frac{1}{P_{hc} \times (M_{bk} \times M_{hg} + 18(1-M_{hg}))} \right]^{1/2} = V_{hf} _____$$

(12) D. Stack volume @ standard conditions, scfm

$$= \frac{0.123 \times V_{hf} \times S_{dd} \times P_{hc} \times M_{hg}}{(T_{hd} + 460)} = V_{hh} = _____$$

(Go to Part 5, p. 2)

M_{bk} from Orsat data and calculation sheet (Part 7).

Part 5, p. 1 of 2

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VELOCITY DATA AND CALCULATION SHEET FOR TEST
(Burners and Waste)

Date _____ Time _____

Sampling point location _____ Run No. _____

Stack area (S_{dd}), in.^{2} _____

Note: Calculations for S-type pitot tube, C = 0.85

Drawing of stack cross section

Point No.	Distance from ref. point, in.	Stack press. (P_{dj}), in. Hg (gage)	Stack temperature (T_{df}), ^oF	Stack temperature (T_{df} + 460), ^oR	Velocity head (V_b), in. H_2O	$V_b \times (T_{df} + 460)$	$\sqrt{V_b \times (T_{df} + 460)}$
		Avg = ____	Avg = ____				Avg (S_{de}) = ____

in. Hg abs) =

(P_{di}) = P_{dj} + P_{aa} = _____

P_{aa} from particulate sampling train sheet (Part 3).

(13) A. Stack velocity @ P_{di} and T_{df} (stack conditions), fpm

$$= 4350 \times S_{de} \times \left[\frac{1}{P_{di} \times M_{ca}}\right]^{1/2} = V_{dh} \quad _____$$

(14) B. Stack volume @ standard conditions, scfm

$$= 0.123 \times \frac{V_{dh} \times S_{dd} \times M_{ch} \times P_{di}}{(T_{df} + 460)} = V_{db} = \quad _____$$

(Go to Part 7, p. 2.)

M_{ca}, M_{ch} from stack moisture data and calculation sheet (Part 6).

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STACK MOISTURE CONTENT DATA AND CALCULATIONS FOR TEST

Date _____

Run No.				
H_2O condensed in impingers (V_{cb}), ml				
H_2O absorbed by silica gel (V_{cd}), ml				
Total H_2O collected = V_{ce} = (V_{cb} + V_{cd}), ml				
Vol of H_2O vapor @ 70°F and 29.92 in. Hg = 0.0474 x V_{ce} = (V_{cf}), cf				
Moisture in stack gas = (V_{cg}), % (from formula below)				
Mole fraction dry gas, = (M_{ch}) (from formula below)				
Molecular weight of stack gas (M_{ca}) (from formula below)				

(6) A. Moisture in stack gas (V_{cg}), %

$$= \frac{100 \times V_{cf}}{V_{ab} + V_{cf}}$$

(7) B. Mole fraction dry gas (M_{ch})

$$= \frac{100 - V_{cg}}{100}$$

(8) C. Molecular weight of stack gas

$$M_{ca} = M_{bj} \times M_{ch} + 18 (1 - M_{ch})$$

(Go to Part 4, p. 2.)

V_{ab} from particulate data and calculation sheet (Part 3).

M_{bj} from Orsat data sheet (Part 7).

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ORSAT DATA AND CALCULATION SHEET

Orsat Analysis - Burner Only (From bag sample)

Sampling point location _____

Date _____ Time _____

	Analysis 1	Analysis 2	Analysis 3	Avg	x = mole.wt	wt/mole (dry)
CO_2 (V_{bb}), % vol (dry)					44/100	
CO (V_{bc}), % vol (dry)					28/100	+
O_2 (V_{bd}), % vol (dry)					32/100	+
N_2 (V_{be}), % vol (dry)					28/100	+
					M_{bk} = Avg molecular wt of dry stack gas=	———

Orsat Analysis for Test - Waste and Burners (From bag sample)

Date _____ Time _____ Run No. _____

Sampling point location _____

	Analysis 1	Analysis 2	Analysis 3	Avg	x = mole wt	wt/mole (dry)
CO_2 (V_{bf}) % vol (dry)					44/100	
CO (V_{bg}), % vol (dry)					28/100	+
O_2 (V_{bh}), % vol (dry)					32/100	+
N_2 (V_{bi}), % vol (dry)					28/100	+
					M_{bj} = Avg molecular wt of dry stack gas =	———

(28) A. Excess air, %

$$= \frac{100 \times (V_{bh} - \frac{V_{bq}}{2})}{0.264 \times V_{bi} - (V_{bh} - \frac{V_{bq}}{2})} = V_{bl} = _____$$

(Transfer all answers to summary of results)

(15) B.* CO_2 contributed by burner, % by volume of stack gas corrected to test conditions.

$$V_{bn} = V_{bb} \times \frac{V_{hh}}{V_{db}} \times G_{bm} = _____$$

(16) B. CO_2 in stack gas from waste, % vol (dry)
(Go to Part 3, p. 2)

$$= V_{bf} - V_{bn} = V_{ba} = _____$$

V_{db} from velocity data and calculation sheet for test (Part 5).

V_{hh} from velocity traverse data and calculation sheets (Part 4).

G_{bm} from incinerator data and calculation sheet (Part 10).

Note: Above calculation corrects CO_2 of burner to stack test conditions.

---

* Note: If CO_2 from burners is determined from an analysis of the natural gas flow, the following equation can be used in place of equations (15)and (16) to calculate (V_{ba}).

Z = CO_2 from burners, scfm (Determine from natural gas flow rate) _____

$$V_{ba} = \frac{V_{db} \times V_{bf} - (Z \times G_{bm} \times 100)}{V_{db}} = _____$$

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POUNDS PER HOUR EMISSION CALCULATION

Total particulate collected by train, grams	W_{1a} = _____
Area of sampling nozzle, in.^{2}	W_{1b} = _____
Area of stack, in.^{2}	W_{1c} = _____
Time of particulate test, min.	W_{1d} = _____

Emissions, lbs/hr

$$= \frac{0.132 \times W_{1a} \times W_{1c}}{W_{1b} \times W_{1d}} =$$ C_{ay} = _____

Note: Sufficient data and calculations should be included to show that the particulate train was operated within 10 percent of isokinetic conditions. Comparison of the probe sampling velocity to the stack gas velocity will be sufficient for this purpose. To make this comparison it will be necessary to measure:

1. Stack temperature
2. Stack velocity
3. Sampled gas volume and temperature
4. Moisture in sampled gas

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STICKY PAPER DATA AND CALCULATIONS

Date _____

Stack area, $in.^2$ _____

Sampling point location _____

Run No. _____

Time	$Part/in.^2/min$ > 60 microns	Part/min >60 microns
	Avg	Avg

Note: Particles/min = stack area x $part/in.^2/min$.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
National Center for Air Pollution Control

FORM APPROVED
BUDGET BUREAU
NO. 68R-1056
APPROVAL EXPIRES
Jan. 1973

INCINERATOR OPERATING DATA AND CALCULATION SHEET

Date_____

Run No._____

Clock time	Material charged, lb	Primary chamber draft		Secondary chamber	Stack opacity	Comments
		Overfire, in. H_2O	Underfire, in. H_2O (Optional)	Temp. oF	%	
	Net = ——	Avg = ——	Avg = ——	Avg = ——	Avg = ——	

Fraction of time all burners are operating (G_{bm}) = _____

DEFINITIONS

Standard conditions - 70°F and 29.92 in. Hg

scf - Standard cubic foot of dry gas @ 70°F and 29.92 in. Hg

scfm - Standard cubic foot per minute of dry gas @ 70°F and 29.92 in.Hg

Stack conditions - stack temperature, pressure, and moisture.

LIST OF SYMBOLS

Part 3. Particulate sampling train data and calculation sheet

C_{am}, Particulate-probe and cyclone, grains/scf

C_{an}, particulate-probe, cyclone and filter, grains/scf

C_{ao}, Particulate-total, grains/scf

C_{ap}, particulate-probe, cyclone and filter, grains/scf @ 12 % CO_2

C_{aq}, particulate-probe, cyclone and filter, grains/scf @ 12 % CO_2

C_{ar}, particulate-total, grains scf 12 % CO_2

C_{as}, particulate-probe and cyclone, grains/scf @ stack conditions

C_{at}, particulate-probe, cyclone and filter, grains/cf @ stack conditions

C_{au}, particulate-total particulate, grains/cf @ stack conditions

C_{av}, particulate - probe and cyclone, lb/hr

C_{aw}, particulate - probe, cyclone and filter, lb/hr

C_{ax}, particulate - total, lb/hr

D_{av}, sampling nozzle diameter, in.

P_{aa}, barometric pressure, in.Hg (Absolute)

P_{af}, orifice pressure drop, in. H_2O

T_{ad}, gas meter inlet temperature, ^oF

T_{ae}, gas meter exit temperature, ^oF

T_{ai}, average gas meter temperature, ^oF

T_{aw}, net time of test, minutes

T_{ax}, percent isokinetic

V_{ab}, volume of dry gas sampled @ standard conditions, ft^3

V_{ac}, Volume of dry gas sampled @ meter conditions, ft^3

W_{aj}, particulate-probe and cyclone, mg

W_{ak}, particulate-probe, cyclone and filter, mg

W_{al}, particulate - total, mg

Part 4. <u>Velocity traverse data and calculation sheet</u>(burners only)

M_{hg}, mole fraction dry gas

P_{hc}, stack pressure, in.Hg. (absolute)

P_{hl}, barometric pressure, in. Hg.(absolute)

P_{hm}, stack pressure, in. Hg. (gage)

S_{dd}, stack area, $in.^2$

S_{he}, average $\sqrt{\text{Velocity head x stack temperature.}}$

T_{hd}, average stack temperature, ^oF

T_{hj}, wet bulb temperature, ^oF

T_{hk}, dry bulb temperature, ^oF

V_a, Velocity head of stack gas (burner only) in. H_2O

V_{hf}, stack gas velocity, fpm @ stack conditions

V_{hh}, stack gas volume @ standard conditions, scfm

V_{hi}, moisture in stack gas by volume, %

Part 5. Velocity data and calculation sheet for test (burners and waste)

P_{di}, stack pressure, in Hg (absolute)

P_{dj}, stack pressure, in. Hg (gage)

S_{dd}, stack area, in^2

S_{de}, average $\sqrt{\text{Velocity head x stack temperature}}$

T_{df}, stack temperature, ^{o}F

V_b, velocity head of stack gas burner and waste, in. H_2O

V_{db}, stack gas volume @ standard conditions, scfm

V_{dh}, stack velocity @ stack conditions, fpm

Part 6. Stack moisture content data and calculation sheet

M_{ca}, molecular weight of stack gas

M_{ch}, mole fraction of dry gas

V_{cb}, H_2O condensed in impingers, ml

V_{cd}, H_2O absorbed silica gel, ml

V_{ce}, total H_2O collected, ml

V_{cf}, volume of water vapor collected, cu ft @ standard conditions

V_{cg}, moisture in stack gas by volume, %

Part 7. Orsat data and calculation sheet

G_{bm}, fraction of test time all burners are operating

M_{bj}, molecular weight of dry stack gas (waste and burner)

M_{bk}, molecular weight of dry stack gas (burner only)

V_{ba}, % CO_2 from waste (dry basis)

V_{bb}, % CO_2 from burner (dry basis)

V_{bc}, % CO from burner (dry basis)

V_{bd}, % O_2 from burner (dry basis)

V_{be}, % N_2 from burner (dry basis)

V_{bf}, % CO_2 from waste and burner (dry basis)

V_{bg}, % CO from waste and burner (dry basis)

V_{bh}, % O_2 from waste and burner (dry basis)

V_{bi}, % N_2 from waste and burner (dry basis)

V_{bl}, % excess air at sampling point

V_{bn}, CO_2 contributed by burner, % by volume of stack gas corrected to test conditions